Key Metrics for Evaluating Maritime Supply Chain Performance: Insights from Literature

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***Abstract*— Evaluating performance metrics in maritime supply chain in crucial for achieving operational efficiency, resilience, and service reliability in an increasingly complex global shipping environment. This Study systematically reviews 31 peer-reviewed articles published between 2010 and 2024 to identify, classify, and analyse key performance metrics used in the maritime logistics sector. The review was conducted using four major databases-ScienceDirect, Google Scholar, SpringerLink, and EBSCO Host- following the PRISMA framework. This study employs a systematic literature review (SLR), incorporating thematic analysis to identify and synthesize common patterns across the selected literature. The findings are categorized into three main dimensions: operational efficiency (e.g., berth productivity, vessel on-time performance, ship turnaround time), resilience (e.g., disruption recovery time, supply chain redundancy, routing flexibility), and servicer reliability (e.g., customer satisfaction, delivery accuracy, schedule adherence)**

The novelty of this paper lies in the development of a comprehensive and structured framework that integrates these key performance metrics, providing maritime stakeholders with actionable insight for performance evaluation and strategic alignment. This farmwork not only synthesizes current academic perspectives but also incorporates digitalization and technological readiness as enablers of enhanced Supply Chain performance. The outcome offers valuable guidance for decision-makers aiming to optimize resource allocation, mitigate risks, and improve overall competitiveness in maritime logistics.

Keywords— *Maritime Supply Chain, Operational Efficiency, Resilience, Service Reliability, Performance Metric*

1. Introduction

Maritime transport is the backbone of global trade, with approximately 80% of the world's merchandise volume transported by sea. The complexity of maritime supply chains, compounded by evolving global challenges such as geopolitical tensions, climate change, and technological disruptions, demands the adoption of robust performance measurement systems. Ref. [1] underscores the importance of evaluating maritime supply chain performance to enhance operational efficiency, resilience, and service reliability. As maritime and shipping operations function in increasingly complex environments, many companies are placing greater emphasis on supply chain optimization (Ref. [2]). Over the past decade, this shift has led to a transformation in how performance is measured and managed, making it essential for industry stakeholders to enhance resilience and streamline operations.

Ref. [3] emphasizes that operational efficiency plays a pivotal role in maritime logistics, as it influences service quality, sustainability, and cost-effectiveness. This is reinforced by Ref. [4], which notes that while traditional performance metrics focused on efficiency and cost control, current supply chain environments require a more holistic approach to capture operational dynamics. Ref. [5] also highlights that effective supply chain metrics in liner shipping directly impact service delivery and customer satisfaction.

In the maritime sector, supply chain performance metrics are typically categorized into three key dimensions: operational efficiency, resilience, and service reliability. To assess efficiency, indicators such as vessel turnaround time, port productivity, and inventory turnover are frequently used. In terms of resilience, Ref. [6] identifies redundancy, disruption recovery time, and adaptability as essential metrics. Moreover, Ref. [7] stresses the importance of resilience for reducing downtime and enabling organizations to respond effectively to uncertainty.

Service reliability is another critical pillar of performance. According to Ref. [8], improving logistics processes enhances a port's competitiveness by increasing dependability. Ref. [9] advocates for the use of real-time monitoring and cargo standard evaluations to reduce delays and strengthen stakeholder relations. Technological solutions, including blockchain, are also seen as valuable tools for improving supply chain reliability, as indicated

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by Ref. [10]. Further, Ref. [11] notes that punctuality, customer satisfaction, and cargo safety are vital indicators for ensuring reliable and organized logistics operations.

The concept of resilience is strongly linked to an organization's capacity to withstand disruptions and recover swiftly (Ref. [6]). Ref. [12] cites the COVID-19 pandemic as a significant disruption that exposed the need for robust and adaptive maritime supply chains. Similarly, Ref. [7] suggests that resilience should encompass risk mitigation, redundancy planning, and disruption recovery mechanisms. Ref. [13] further proposes that technologies like artificial intelligence and predictive analytics can support proactive risk assessment and enhance overall resilience. These capabilities help maritime companies minimize downtime and prepare for unexpected challenges.

Continuous monitoring of operational environments is essential for preserving supply chain stability, as recommended by Ref. [14]. Despite increasing digitalization in maritime logistics, persistent challenges still affect operational stability. Resilience is particularly important in managing financial risks, achieving sustainability goals, and ensuring positive social outcomes. As sustainability becomes a growing concern, Ref. [15] suggests that companies must bridge the performance gaps in efficiency, resilience, and reliability to stay competitive.

Based on a comprehensive review of the selected studies, this paper proposes a structured framework for evaluating maritime supply chain performance. The framework incorporates digitalization as a catalyst for improving efficiency, resilience, and reliability. It is intended to guide maritime stakeholders in aligning supply chain practices with strategic objectives, ensuring competitiveness in a volatile global market.

The paper is structured as follows: the next section presents the research methodology, followed by the key findings derived from the literature review. The discussion section interprets the results in the context of maritime supply chain performance, and the final section concludes the study with practical implications and recommendations for future research.

2. Research Methodology

Selecting a suitable research methodology is essential to ensure the study achieves its intended objectives. This research adopts a **systematic literature review (SLR)** as the primary methodological approach, which is appropriate for synthesizing existing knowledge and identifying recurring themes within a well-defined scope. While SLRs do not typically aim to formulate new theories, they can serve as a robust foundation for developing conceptual models and frameworks (Refs. [16], [17]).

In this study, the SLR is supported by an interpretive lens, utilizing thematic analysis to extract key patterns related to performance metrics in maritime supply chains. This approach enables the researcher to derive meaningful insights into how operational efficiency, resilience, and service reliability are evaluated across various studies. The resulting framework offers theoretical and practical contributions, particularly in aligning performance metrics with strategic goals in maritime logistics ecosystems.

The review process focused on identifying relevant publications addressing performance evaluation in maritime supply chains, particularly metrics associated with efficiency, resilience, and reliability. Systematic literature reviews are instrumental in mapping the existing knowledge base within a discipline, offering a structured synthesis that supports scholarly progress (Ref. [18]). In this context, the literature review provides a comprehensive understanding of maritime supply chain performance while accounting for evolving challenges such as digital transformation, sustainability demands, and global uncertainties. It also highlights existing research gaps and proposes directions for future inquiry (Refs. [19], [17], [20]).

2.1. Data sources and search terms

To ensure a comprehensive and systematic review, electronic searches were conducted across three major academic databases: SpringerLink, ScienceDirect, and EBSCO Host. In addition, Google Scholar was utilized to broaden the search scope and capture relevant grey literature or supplementary peer-reviewed studies not indexed in the primary databases. These databases were selected due to their wide coverage of scholarly journals and robust filtering capabilities, which enabled the researcher to refine search results and extract high-quality, peer-reviewed articles relevant to the maritime supply chain domain.

The search was conducted between November 2024 and February 2025, focusing on publications from 2010 to 2024. This time frame was chosen to ensure the inclusion of recent literature while covering a sufficient historical range to identify trends and developments in performance metrics.

Search terms were initially broad but were progressively refined to improve the precision and relevance of the results. Keywords and phrases used included: "maritime supply chain performance", "operational efficiency", "resilience", "service reliability", and "sustainability". These terms were selected to capture literature that addresses both traditional performance dimensions and emerging themes influenced by global disruptions and digital transformation.

Following the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) framework, all retrieved articles were screened for relevance and alignment with the study's objectives (Refs. [18], [21]). Table 1 summarizes the databases searched and the queries applied during the process, highlighting how

search terms were refined iteratively to identify the most relevant studies.

Table 1: Search Database

Database/Source	Query
EBSCO Host	(maritime supply chain) (performance metrics) (evaluation)
	(maritime logistics) (performance assessment) (key indicators)
	(maritime supply chain) (efficiency OR resilience OR reliability) (key metrics)
	(maritime supply chain OR shipping industry) (performance evaluation) (operational efficiency OR service reliability OR resilience)
ScienceDirect	maritime supply chain performance metrics
	maritime logistics OR shipping industry performance evaluation
	Key Performance Indicators for Maritime Supply Chains
	factors influencing maritime supply chain efficiency OR resilience OR service reliability
SpringerLink	factors AND maritime supply chain AND performance AND key metrics
	maritime logistics AND performance evaluation AND (operational efficiency OR service reliability OR resilience)
	(shipping industry OR maritime transport) AND performance assessment AND (efficiency OR resilience OR key performance indicators)
Google Scholar	Key metrics for evaluating Maritime Supply Chain Performance Peer-reviewed English
	Maritime Logistics performance indicators peer-reviewed English.
	Operational efficiency OR service reliability OR resilience in maritime supply chains peer-reviewed English.
	factors OR influences OR determinants of maritime supply chain Performance peer-reviewed English
Google Search	maritime supply chain performance evaluation statistics

2.2. Inclusion and exclusion criteria

Establishing clear inclusion and exclusion criteria is essential for ensuring the transparency and rigor of a systematic literature review. As emphasized by Ref. [16], systematic reviews must explicitly define the scope of literature considered, including both what is included and excluded. According to Ref. [19], these criteria should align with the search strategy, source types, publication timeframe, and disciplinary relevance.

For this study, the inclusion criteria focused on **English-language, peer-reviewed journal and conference articles** accessible through academic databases. Only studies published between **2010 and 2024** were considered, in order to ensure the review reflects recent developments in maritime supply chain performance.

The exclusion criteria comprised:

- Publications in languages other than English
- Articles published before 2010
- Non-peer-reviewed materials such as editorials, commentaries, opinion pieces, and news articles

These criteria were designed to ensure the quality, relevance, and academic credibility of the sources analyzed in this review.

2.3. Bias

While efforts were made to minimize bias throughout the review process, the researcher acknowledges that some level of subjectivity is inherent in interpretive research, as supported by Ref. [16] and Ref. [22]. Rather than eliminating bias entirely, it was **consciously managed and embraced** as part of enhancing the **authenticity, transparency, and trustworthiness** of the research process.

Three main types of bias were considered: **review design bias, selection bias, and synthesis bias** (Ref. [17]). To reduce **review design bias**, the study was guided by clearly defined and structured research questions developed prior to database engagement. This ensured a focused and objective approach during article retrieval and screening.

To mitigate **selection bias**, a systematic and transparent inclusion process was followed, and the selection of literature was not limited to the researcher's individual interpretation. Concepts and inclusion criteria were clearly defined to ensure consistency and replicability, as recommended by Ref. [23].

Synthesis bias was addressed by adhering to a consistent analytical framework. The use of thematic analysis—applied uniformly across all selected papers—helped ensure that the emerging themes were well-grounded in the literature. This structured approach contributed to the reliability and credibility of the study's findings.

2.4. Data extraction

The data extraction process was carried out between **January and February 2025**, following systematic search procedures across the selected databases. Multiple combinations of keywords were applied in **SpringerLink, ScienceDirect, EBSCO Host**, and **Google Scholar** to maximize the breadth of relevant search results. As expected in multi-database searches, a substantial number of **duplicate records** emerged. These were carefully identified and excluded from the final selection.

The initial search yielded approximately **2,000 records**, though this figure included significant overlap across databases. This aligns with previous SLRs, such as Ref. [24], which began with over 24,000 sources and narrowed down to only 112 eligible studies. To manage this process effectively, the **PRISMA framework** was adopted, enabling a structured screening process that reduced the inclusion of irrelevant or low-impact studies (Refs. [25], [17]).

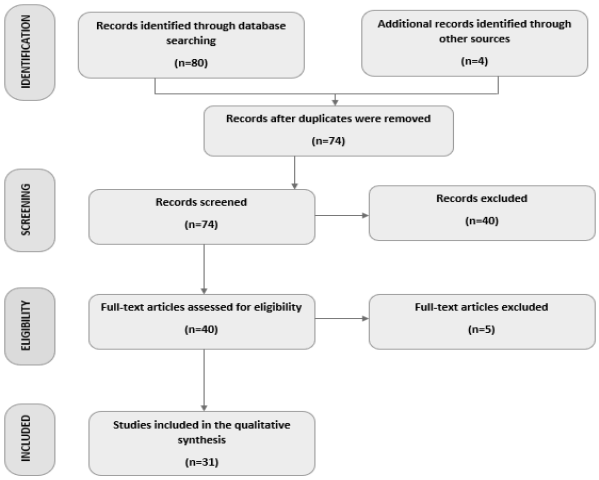
To refine the dataset, filters were applied to limit results to **peer-reviewed journal articles** published between **2010**

and 2024. This screening process produced **80 initial records**. After removing **six duplicates**, **74 articles** remained and were subjected to further screening based on relevance. Articles that did not focus on **maritime logistics** or lacked full-text access were excluded. As a result, **40 articles** were eliminated at this stage.

The remaining **36 full-text articles** were then assessed for thematic alignment with the research objectives. An additional **five articles** were excluded due to limited relevance to **maritime supply chain performance**. Ultimately, **31 articles** were retained for in-depth analysis, each providing insights into performance metrics related to **operational efficiency, resilience, and service reliability**.

Figure 2 presents the PRISMA flowchart outlining the step-by-step screening and selection process used in this study.

Figure 2: PRISMA Flowchart



2.5. Data Analysis

This study adopts a **systematic literature review (SLR)** methodology to ensure transparency, replicability, and depth in identifying and analyzing performance metrics relevant to maritime supply chains. Within the SLR process, **thematic analysis** was employed as the primary analytical tool to extract, categorize, and synthesize insights from the **31 selected articles**. This method was chosen for its effectiveness in identifying recurring patterns and organizing them into meaningful themes—specifically aligned with the key dimensions of **operational efficiency, resilience, and service reliability** (Ref. [26]).

Thematic analysis was conducted following the six-phase framework proposed by **Braun and Clarke** (Ref. [27]). The process began with a thorough reading of all selected articles to gain familiarity with the content. In the second phase, initial codes were generated manually, focusing on recurring performance indicators and key ideas across the literature. Coding was performed at both the sentence and paragraph levels.

In the third phase, related codes were clustered into broader themes. To ensure rigor and validity, only themes that were supported by at least two independent sources were retained. During the fourth phase, the themes were reviewed and refined to confirm their accuracy and relevance. In the fifth phase, each theme was clearly defined and appropriately named. Finally, a **narrative synthesis** was developed, using illustrative examples from literature to support each identified theme.

This analytical process allowed for the systematic consolidation of dispersed academic knowledge into a unified **framework of maritime supply chain performance metrics**. Moreover, it contributed to reducing synthesis and interpretation bias—an important consideration in qualitative data analysis within literature reviews.

3. Findings

3.1. General findings

In this paper, the findings are extracted and detailed using a comprehensive matrix in the appendix. All 31 articles included have been thoroughly read, analysed, and recorded. During analysis, it was found that not all findings correlated directly with supply chain performance in the maritime industry. It was found that most articles proposed supply chain performance frameworks. Within these studies, and based on the research objectives, it was found that they could be classified under operational efficiency, resilience, and service reliability. This called for further coding procedures to tabulate the findings. After coding and reviewing the themes, it was established that the metrics to measure maritime supply chain performance are broad, and these are discussed in the following section.

3.2. Service Reliability Metrics

The articles also found that service reliability is integral to ensuring customer satisfaction and long-term business relationships in maritime logistics. Service reliability metrics directly influence maritime contractual agreements between carriers and shippers. Companies with impressive track records in on-time deliveries and minimal cargo damage are mostly preferred partners, securing long-term contracts.

3.2.1. Customer Satisfaction Measures

[14] claim that customer satisfaction levels must be measured for reliability. These are derived from feedback from shippers and consignees about the reliability and quality of maritime services. There are several customer satisfaction measures, including order fulfilment rates, customer satisfaction surveys, and customer complaint resolution, that maritime companies can use to understand customer satisfaction levels. This explains why a well-

structured feedback mechanism and prompt responses to complaints have better customer relationships and higher satisfaction levels. Shipping companies seek higher fulfilment rates for operational efficiency and supply chain reliability using real-time inventory tracking and automated dispatching systems. Customer satisfaction surveys help maritime companies collect clients' direct feedback regarding their maritime logistics services experiences [14]. Data from customer satisfaction surveys indicate pain points that need to be improved in service reliability.

3.2.2. Cargo Delivery Accuracy

[28] claimed that measures for cargo delivery accuracy are vital for appraising the dependability of maritime services. This pertains to the count of deliveries received at the right address without any damages or mistakes [29]. [30] suggests that maritime firms focusing on high schedule reliability can promote stakeholder matters, as lessening shipment interruptions may reduce downstream disruptions. For example, implementing smart container monitoring, RFID tracking, and computerized scanning systems has significantly boosted accuracy rates.

3.2.3. Schedule Reliability

[31] argue that schedule reliability should be assessed. This pertains to the percentage of shipments arriving within the expected timeframe and is critical to planning downstream logistics. Schedule reliability is crucial for customers who rely on predictable delivery times for inventory management and production schedules [32]. Customs clearance procedures, vessel delays, and port congestion impact the schedule reliability metric. A port that experiences congestion mostly results in delayed vessel berthing, impacting supply chain stability [33]. Shipping companies have adopted real-time monitoring and big data analytics to improve schedule adherence and minimize deviations [34]. With these digital tools, shipping companies can project potential delays and adjust their schedules to maintain on-time performance. Some ports use automated berthing allocation and intelligent traffic management processes to reduce scheduling disruptions and ensure supply chain sustainability.

3.2.4. Transit Time Consistency

Transit time consistency estimates the difference in delivery times for shipments. Unreliable shipping schedules result in uncertainty in supply chain management, resulting in higher buffer inventories and disorganizations [35]. Unpredictable transit times can interrupt shipping logistics, resulting in higher operational costs, levels of safety stock, and shortages. Weather conditions, regulatory delays, and port efficiency affect the reliability of transit times [32]. Maritime companies commissioning advanced weather prediction and extrapolative analysis are better prepared to anticipate changes in delivery schedules, improving overall dependability. Analysing past shipment performance could help maritime companies create reliable schedules to handle possible disruptions effectively.

3.3. Resilience Metrics

Maritime companies must implement risk mitigation plans such as emergency response measures, recovery strategies, and monitoring systems to boost their long-term resilience. According to [36], owing to issues ranging from geopolitics and climate change, disruptions are common, and supply chains must be adaptable to deal with these changes.

3.3.1. Disruption Recovery Time

In maritime supply chains, disruptions are common, and it is recommended that supply chain managers assess the external environment for potential disruptions. Maritime companies must evaluate the time they take to recover from a disruption, whether expected or unexpected. The disruptions include worker strikes, adverse weather patterns, and geopolitical issues. When supply chains are affected by these disruptions, operational stability is affected. To thrive in a competitive industry, recovering from these disruptions should be prompt to avoid further delays along the supply chain [37]. Additionally, the sources examined revealed that ports must have solid redundancy strategies and backup plans to overcome disruptions. These should also be supported by robust infrastructure that helps supply chain managers use digitalization to hasten recovery [38].

3.3.2. Supply Chain Redundancy

Redundancy is an effective strategy that addresses supply chain risks. Redundancy involves having backup alternatives for continuity of supply chain operations during a crisis. This could imply having multiple suppliers for a single component or alternative transportation routes. These options are evaluated for their effectiveness in helping a company to stay resilient [39, 15]. A failure to assess redundancy can lead to maritime supply chains having a single point of failure, which can eventually disrupt the entire supply chain, resulting in higher costs and loss of stakeholder trust. Disruptions such as COVID-19 showed why redundancy is necessary to allow maritime companies recover faster and streamline operations [13].

3.3.3. Routing Flexibility

In the supply chain, routing flexibility is considered the ability to dynamically adjust delivery routes based on changing conditions, including inventory levels, unexpected disruptions, and demand fluctuations.

According to [40], routing flexibility assessment help maritime companies to optimize supply chains and quickly respond to changing needs without significant disruptions to operations. Further, research by [5] argues that for maritime companies looking to choose an efficient route at any time using real-time data and conditions, routing flexibility should be assessed.

3.4. Operational performance metrics

A review of the literature found that operational efficiency metrics are integral in maritime supply chains since they directly impact resource utilization, speed, and cost.

3.4.1. Container Dwell Time

Container dwell time represents the amount of time that a container spends at a particular location. Longer dwell times are caused by delays in customs, clearances, poor infrastructure, and port management processes [41, 42]. Container dwell time can also be influenced by warehouse management efficiency, storage space availability, and local traffic conditions. According to [43], assessing the container dwell time is necessary to effectively manage costs such as warehousing. Longer dwell times can lead to higher shipping costs, longer lead times, and lower customer satisfaction levels [44]. To assess the dwell time, investments in container tracking technologies are recommended. These provide real-time data to better forecast demand.

3.4.2. Berth Productivity

Berth productivity is considered the average number of containers moves per crane per hour while a ship is at berth. Berth productivity measures how much cargo is moved through a particular berth in a certain amount of time [45]. This measurement can be used to evaluate the overall efficiency in container terminals and ports. In most ports, [46] argued that automated systems such as cranes were introduced for faster ship unloading, increasing berth productivity. Further, [47] claim that promoting better berth productivity upsurges the chances of maintaining supply chain efficiency. Improved technologies have continued becoming efficient and measuring berth productivity has become common. Digitalization should be used, providing port authorities with detailed data and identify ways to improve berth productivity [48, 1].

3.4.3. Vessel On-Time Performance

Vessel on time is a metric used to measure vessel schedule reliability. Vessels are expected to arrive and leave at ports followed a planned schedule. Better vessel-on-time performance is an indicator of performance excellence and maritime companies can use this metric to lower their expenditures [4, 50]. Additionally, [51] emphasized that vessel-on-time performance may be used to evaluate the operational output of maritime supply chains. In this context, leveraging measures linked to the SCOR (Supply Chain Operations Reference) framework, shipping companies can measure a vessel's compliance with planned departure and arrival times, influencing operational logistics.

3.4.4. Ship Turnaround Time

Ship turnaround time is the period a ship spends at a port, from the arrival to departure. This metric is crucial since it influences a ship's schedule, operational costs, and overall efficiency of maritime transport [52]. Research by [2] argues that quick turnaround times are required for lowering congestion in ports, lower docking fees, and encourage cargo throughput. These measures are essential to improve the competitiveness and profitability of shipping operations [3]. The ship turnaround time is impacted by the port infrastructure, workforce management, type of cargo, and technological advancements. According to [4], cargo handling is important to determine the turnaround time, which is crucial to maximize maritime operations profitability.

4. Discussion

This study systematically reviewed 31 peer-reviewed articles to evaluate performance metrics critical to maritime supply chain management. The findings reveal that performance evaluation in this sector revolves around three core dimensions: **operational efficiency**, **resilience**, and **service reliability**.

Under operational efficiency, metrics such as **vessel-on-time performance**, **berth productivity**, and **ship turnaround time** were consistently highlighted. These indicators help streamline operations, minimize delays, and reduce costs.

For resilience, the study found increasing reliance on **digital technologies** such as **artificial intelligence**, **blockchain**, and **automation** to enhance **disruption recovery**, **routing flexibility**, and **supply chain redundancy**. These tools enable organizations to better anticipate and respond to geopolitical, environmental, and market disruptions.

In terms of service reliability, performance is closely tied to **customer satisfaction**, **cargo delivery accuracy**, and **schedule adherence**. Maritime firms that maintain dependable delivery schedules and reduce inconsistencies gain a competitive edge by improving client retention and trust.

Table 2 presents a summary of the selected articles, detailing their methodologies and contributions to the identified performance themes.

Table 2: Summary of key arguments in the papers

Reference	Objective	Method Used	Contribution to the Paper
Panayides et al. [1]	To measure supply chain performance in complex shipping environments	Empirical research	Developed a performance measurement framework for shipping networks
Premathilaka [2]	To determine factors affecting turnaround time in container vessels at Port of Colombo	Case study analysis	Identified key operational factors influencing port turnaround time
Sant'Anna & Kannebley Júnior [3]	To analyse port efficiency and its impact on Brazilian exports	Quantitative assessment	Provided insights on how port turnaround time affects international trade
Ducruet & Merk [4]	To examine global container vessel turnaround times	Comparative global study	Established benchmarks for port efficiency and turnaround time
Mason & Nair [5]	Examines supply-side strategic flexibility capabilities in container liner shipping and how companies adapt to market conditions, operational uncertainties, and customer demands.	Qualitative research	Introduced metrics to understand the efficiency of vessel deployment
Macdonald & Corsi [6]	To examine severe events and recovery in supply chains	Business logistics analysis	Provided a framework for recovery strategies in maritime disruptions
Yuen & Thai [7]	To evaluate service quality and customer satisfaction in liner shipping	Survey-based study	Identified factors influencing customer satisfaction in maritime logistics
Okur & Tuna [8]	To study schedule reliability in global shipping	Comparative analysis	Provided insights on global trends in schedule reliability
Naumov [9]	To model international cargo delivery processes	Quantitative modelling	Introduced optimization models for improving cargo handling
Kyrychenko et al. [10]	To assess cargo delivery quality using fuzzy logic	Fuzzy set analysis	Developed a framework for evaluating cargo accuracy
Chung & Chiang [11]	To evaluate critical factors affecting schedule reliability	Quantitative evaluation	Identified key factors influencing schedule adherence in liner shipping
Rogerson et al. [12]	To examine supply chain disruptions and flexibility measures	Case study analysis	Suggested redundancy strategies to mitigate supply chain risks
Liu et al. [13]	To translate maritime supply chain resilience concepts into practice	Industrial case study	Provided real-world applications for resilience measures
Yuen & Thai [14]	Investigates the relationship between service quality and customer satisfaction in the liner shipping industry, identifying key service quality dimensions that impact customer perceptions.	structural equation modelling	Identifies service quality as a crucial factor in supply chain performance, emphasizing reliability
Liu et al. [15]	To link supply chain resilience to firm performance in liner shipping	Empirical research	Established resilience as a key factor for maritime success
Kyrychenko [28]	assess cargo delivery quality in maritime logistics using fuzzy set theory to handle uncertainty and imprecision	Experimental research	Introduces a structured method for evaluating cargo delivery performance under uncertainty
Romanuke et al. [29]	To optimize maritime cargo delivery using genetic algorithms	Algorithmic research	Proposed AI-based optimization methods for cargo delivery accuracy
Zhang & Lee Lam [32]	To assess schedule reliability and sailing frequency	Policy and logistics analysis	Examined the impact of reliability on shipping and port industries
Elmi et al. [33]	To review uncertainties and schedule recovery in liner shipping	Systematic review	Analysed strategies for handling disruptions in shipping schedules
Ivanov et al. [37]	To review literature on disruption recovery in supply chains	Systematic literature review	Established theoretical foundations for managing disruptions in maritime supply chains
Notteboom et al. [38]	To compare disruptions in global container shipping	Comparative analysis	Highlighted key resilience factors in maritime disruptions
Zhang et al. [40]	To propose flexible solutions for maritime inventory routing	Operations research modelling	Developed solutions for improving routing flexibility
Sidik et al. [41]	To model and optimize dwell time in Indonesian ports	Optimization modelling	Suggested improvements for reducing container dwell time
Moini et al. [42]	To determine factors affecting container dwell times	Statistical regression	Identified determinants of dwell time and its impact on logistics
Kourounioti et al. [43]	To develop predictive models for container dwell times	Artificial Neural Networks	Introduced AI applications for predicting and reducing dwell times
De Armas Jacomino et al. [44]	To estimate import container dwell times using machine learning	Ordinal regression modelling	Developed predictive models for container dwell time estimation
Dwarakish [45]	To measure port performance and productivity	Performance measurement framework	Developed a systematic approach for assessing berth productivity
Golias et al. [46]	To optimize berth-scheduling to reduce emissions	Optimization modelling	Provided strategies for maximizing berth productivity while minimizing environmental impact
Beškovnik et al. [47]	To compare berth productivity at Eastern Adriatic container terminals	Comparative terminal analysis	Identified productivity improvement strategies for container terminals
Lu & Wang [48]	To identify critical factors for berth productivity	Case study analysis	Highlighted key elements affecting terminal operational efficiency
Meersman et al. [50]	To evaluate vessel train performance	European transport study	Provided insights into improving vessel scheduling and efficiency
Ducruet et al. [51]	To evaluate time efficiency at global container ports	International transport analysis	Assessed the impact of time efficiency on vessel on-time performance
Kuznetsov et al.	To analyse cargo plan influence on turnaround time	Simulation	Demonstrated the impact of cargo

[52]		modelling	planning on reducing port delays
Mason & Nair [54]	To analyse supply-side strategic flexibility in liner shipping	International logistics study	Provided insights into routing flexibility as a competitive advantage
Pinakpani et al. [55]	To develop an algorithmic approach for maritime transportation	Algorithm development	Improved predictive models for transit time consistency
Li et al [56]	To develop recovery models for liner shipping	Mathematical modelling	Created optimization strategies for vessel disruption recovery

5. Conclusion

This paper offers a comprehensive **framework of performance metrics** for evaluating maritime supply chains, grounded in a systematic literature review spanning 2010–2024. The framework identifies and categorizes metrics under three main themes: operational efficiency, resilience, and service reliability.

The **key findings** highlight that:

- Efficiency metrics such as **berth productivity** and **turnaround time** are vital for reducing operational bottlenecks.
- Resilience is driven by technologies like **AI** and **predictive analytics**, which help maritime firms anticipate and recover from disruptions.
- Service reliability depends heavily on **schedule adherence** and **customer-centric performance indicators**, such as cargo accuracy and satisfaction rates.

The **novelty** of this study lies in its **integration of traditional and digital metrics into a structured framework**, offering actionable insights for both academic research and industry application. Unlike fragmented prior works, this paper synthesizes scattered literature into a unified, accessible format for stakeholders.

This framework enables **maritime stakeholders**, including shipping firms, port authorities, and logistics managers—to align performance evaluation with strategic objectives, improve operational agility, and gain competitive advantage in a fast-evolving global market.

Further Study- While this review presents a robust foundation, future research could explore **empirical validation** of the proposed framework using case studies or quantitative models. Additionally, there is scope for expanding the framework to incorporate **emerging sustainability metrics**, **cybersecurity preparedness**, and **cross-sector benchmarking** within global maritime logistics. Investigating how these metrics influence long-term strategic outcomes would offer valuable contributions to both academia and industry.

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